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Seedbed Preparation Aids Natural Regeneration Of Longleaf Pine

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In south Alabama, establishment, survival, and growth of longleaf pine were improved by winter or fall burning before seedfall. Mechanical seedbed preparation was helpful after a fire and imperative when no burn was made.

Additional keywords: *Pinus palustris* Mill., shelterwood, direct seeding, supplemental seeding.

Deficient seed supply is a problem in the natural regeneration of longleaf pine (*Pinus palustris* Mill.). The species is less fruitful than other major southern pines, and bumper crops may be some years apart. Marginal crops occur more frequently, and then the forester has a choice of at least two measures. He may try to increase tree percent (number of established seedlings per 100 seeds) by careful preparation of the seedbed. He may also reinforce the natural crop by distributing seed that has been treated with materials repellent to predators.

This paper reports a 7-year study to appraise various types of bed preparation and test the utility of supplemental seeding.

METHODS

Layout.—The study was on two sharply contrasting sites of the Escambia Experimental Forest in south Alabama. One site, hereafter called good, was a Bowie soil characterized by a fine sandy loam A horizon grading to a sandy clay B horizon at about 26 inches. Understory vegetation was mainly gallberry, *Ilex glabra* (L.) Gray, less than 4 feet high. Larger brush and hardwoods had been controlled with chemicals or fire 2 or more years previously. The second, and poorer, site was an Alaga soil with nothing heavier than a loamy sand within 4 feet of the surface. Understory vegetation was principally grass dominated by little bluestem (*Andropogon scoparius* Michx.). Topogra-

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phy was level at both locations. The overstory was pure longleaf pine about 60 years old, ranging in density from 30 to 60 square feet of basal area per acre.

Five annual replications began with the 1966 and concluded with the 1970 seed year. Three blocks were established annually on each of the two sites. Each block consisted of three 66-foot-square plots. Plots were subdivided into six minor plots.

Burning treatments.—A winter burn, a fall burn, and no burn (check) were randomly assigned among the three plots in each block. Winter burns were made in February, about 9 months ahead of seedfall, on days when air temperatures ranged from 56° to 79°F, relative humidity from 40 to 60 percent, and ground winds from 5 to 10 miles per hour. Fall burns were made between September 15 and October 9, just before seedfall; temperatures ranged from 78° to 90°F, relative humidity from 45 to 60 percent, and ground winds from 2 to 8 miles per hour.

Seedbed treatments.—Six seedbed treatments were superimposed on each burning plot. They included four mechanical treatments, one chemical treatment, and a check or no treatment. Mechanical treatments were:

Disked with a 6-foot tandem farm disk.

Rototilled with a 5-foot machine set to cut 3 to 5 inches deep.

Rototilled and then worked with a 3-foot cultipacker.

Scaribedded with a specially designed implement that includes a scalper followed by a chopper. The scalper is set shallow to clear away debris but leave most of the topsoil in place. The chopper loosens the soil and makes shallow dams perpendicular to the line of travel. Beds are about 3 feet wide.

Mechanical treatments were applied in February on unburned plots and immediately after the fire on burned plots.

The chemical treatment was a soil sterilant (Dalapon[2]) applied in June of each year with a backpack sprayer. Application was at the rate of 20 pounds per acre.

Supplemental seeding.—Seedfall was monitored with five ¼-mil-acre traps on each major plot. The crop of 1967 provided 137,000 seeds per acre on the good site and 41,000 on the poor site. Counts in other years were: none in 1966 and 1970, 2,000 per acre in 1968, and 2,000 to 7,000 in 1969. To supplement these amounts, seed coated with repellents[3] was distributed in quantities sufficient to provide the equivalent of 100,000 natural seeds per acre. It was considerd that one re-

[2] Mention of trade names is for information only, and does not constitute an endorsement by the U. S. Department of Agriculture.

[3] Mann, W. F., Jr. 1970. Direct-seeding longleaf pine. USDA For. Serv. Res. Pap. SO-57, 26 p. South. For. Exp. Stn., New Orleans, La.

pellent-treated seed would be as effective as five natural ones. Thus, 20,000 treated seeds per acre were sown in every year except 1967, when the only supplementation was 12,000 treated seeds per acre on the poor site.

Laboratory germination of treated seeds averaged 76 percent; it ranged from 57 percent in 1969 to 87 percent in 1968.

Examinations and analyses.—In all five yearly replications, an examination was made during March of the year following seedfall and then annually each November through 1973. In the March examination, tree percents were determined for three classes of seed: protected, treated, and natural. Data on protected seed were obtained from three treated seeds sown under each of sixteen ¼-inch wire mesh cones per subplot. Information on treated seed was derived annually from the repellent-coated supplementary sowings, which were not protected by screens. Data on natural seed were from the 1967 crop on good sites, as this was the only instance in which treated seeds were not applied.

Survival percentages are based on the number of seedlings (from treated plus natural seed) that survived from the March counts to the November counts. Growth is in terms of the root collar diameter of the largest seedlings on each of eight ¼-milacre quadrats per subplot in November. Survival and growth through age 6 years were determined only for trees originating from the 1966 and 1967 seedings, as the study was terminated before younger pines reached that age.

Effects of treatment on seedling establishment in each year, and survival and growth through age 6 for seedlings established in 1966 and 1967, were tested by analysis of variance at the 0.05 level of significance. Establishment and survival percents were transformed (arcsin $\sqrt{\text{proportion}}$) before analysis.

RESULTS

Establishment

Effects of site and seedbed treatments on establishment tree percents are shown in table 1.

Both burning and mechanical site preparation significantly improved establishment. The chemical treatment was ineffective. The best mechanical treatment was rototilling plus cultipacking, although differences were minor if treatments were preceded by a burn. The one pass with a light farm disk was not very useful without a burn. The winter burn was somewhat more effective than the fall burn but only with unprotected seeds, especially natural seeds. As often happens, seed predators appeared to be more of a problem on fresh burns than in a 1-year rough.

Table 1.—*Longleaf pine seedling establishment in relation to site, seedbed treatments, and seed origin*

Treatment	Treated seeds: Protected[1] Good site	Treated seeds: Protected[1] Poor site	Treated seeds: Unprotected[2] Good site	Treated seeds: Unprotected[2] Poor site	Unprotected natural seed, good site[3]	Weighted annual average, all seeds and sites
	Tree percent[4]					
No burn						
Disk	28	27	14	15	29	22
Rototill	48	38	21	28	26	34
Roto-cultipack	49	42	28	34	39	39
Scaribed	41	34	22	20	35	30
Chemical	18	21	11	9	16	15
None	23	22	11	12	18	18
Mean	34	31	18	20	27	26
Winter burn						
Disk	51	45	33	30	51	41
Rototill	54	45	31	38	35	42
Roto-cultipack	52	49	33	45	31	45
Scaribed	46	42	22	31	57	37
Chemical	42	37	22	24	41	33
None	46	40	26	28	54	37
Mean	48	43	28	33	45	39
Fall burn						
Disk	50	42	22	21	45	36
Rototill	56	46	27	28	44	41
Roto-cultipack	51	44	33	32	47	41
Scaribed	48	39	20	23	26	33
Chemical	47	36	18	22	21	31
None	45	37	18	25	28	32
Mean	50	41	23	25	35	36
All	44	38	23	26	36	34

[1] All 5 years.

[2] All years but 1967.

[3] 1967 only.

[4] Number of established seedlings in March per 100 seeds dispersed.

The following tabulation illustrates the effectiveness of burning or of the best mechanical treatment in improving tree percents of treated seeds:

	Good site	Poor site
No treatment	17	17
Burn alone	34	32
Mechanical alone	38	38
Burn plus mechanical	44	43

Burning nearly doubled and mechanical treatment more than doubled seedling establishment. Burning followed by the mechanical treatment was more effective than either treatment alone. Site quality apparently had no effect.

Survival and Growth

Survival of seedlings established in 1966 and 1967 was recorded at age 6 (table 2). It was significantly improved by burning and by some types of mechanical treatments on both good and poor sites. Burning greatly improved survival regardless of added treatments. Mechanical treatment was particularly helpful in the absence of a burn but did not consistently improve survival over that achieved with burning alone. Survival was better on good sites than on poor ones.

The relationship of site and seedbed treatments to seedling size at age 6 was based on the root collar diameter of the largest seedling on each ¼-milacre quadrat (table 3). Growth was significantly improved by pre-seedfall burning, but not by mechanical or chemical treatments. Growth did seem to improve after some of the mechanical treatments on unburned sites, however.

APPROXIMATIONS OF SEED REQUIREMENTS

Past observations have indicated that about 20 percent of a natural seedling stand will consist of brown-spot resistant individuals capable of rapid early growth. If the manager's objective is 500 of these superior crop seedlings per acre at age 6, a population of 2,500 seedlings will be necessary at that time. The number of seeds needed to achieve this goal depends on establishment and survival, both of which are affected by seedbed treatments. In table 4, necessary amounts of natural seed have been established for all bed conditions studied. The estimates are based on the tree percents for repellent-coated, protected seeds over 5 years of observation, as they most closely reflected the effect of bed treatments. Predators make large inroads. To allow for them the observed tree percent of 44 for protected seed on the good site was reduced to 20 percent. This value seemed reasonable, as it is close to the 8-year average obtained in regional trials of the shelterwood system of regenerating longleaf pine. Proportionate adjustments were then made in other observed tree percents by multiplying each value by $\frac{20}{44}$ or 0.4545. These values and the sixth-year survival percentages (table 2) provided estimates of the number of seeds needed in each treatment combination to provide 2,500 seedlings at age 6. The formula was:

$$\text{Seeds needed} = \left(\frac{100}{\text{adjusted tree \%}}\right)\left(\frac{100}{\text{survival \%}}\right)(2{,}500)$$

Table 2.—*Survival of established seedlings through age 6*

Treatment	Good site	Poor site
	Percent	
No burn		
Disk	4	1
Rototill	5	5
Roto-cultipack	21	13
Scaribed	21	7
Chemical	6	4
None	6	1
Mean	10	5
Winter burn		
Disk	27	14
Rototill	28	13
Roto-cultipack	19	14
Scaribed	31	30
Chemical	31	24
None	19	15
Mean	26	18
Fall burn		
Disk	28	17
Rototill	27	24
Roto-cultipack	33	14
Scaribed	38	25
Chemical	21	21
None	24	21
Mean	28	20

Table 3.—*Root-collar diameter of largest seedling per 1/4-milacre at age 6*

Treatment	Good site	Poor site
	—*Inch*—	
No burn		
Disk	0.34	0.18
Rototill	.33	.39
Roto-cultipack	.52	.52
Scaribed	.56	.39
Chemical	.28	.29
None	.31	.13
Mean	.39	.32
Winter burn		
Disk	.63	.60
Rototill	.61	.52
Roto-cultipack	.52	.60
Scaribed	.51	.73
Chemical	.54	.61
None	.58	.49
Mean	.56	.59
Fall burn		
Disk	.56	.65
Rototill	.57	.53
Roto-cultipack	.54	.52
Scaribed	.55	.57
Chemical	.49	.57
None	.54	.61
Mean	.54	.58

One word of caution: table 4 is intended only as a rough approximation. Seed requirements vary with local conditions. If they will keep records of their local experience, land managers will have a better guide than is offered by the table.

CONCLUSIONS

It is clear that longleaf pine seedling establishment, survival, and growth through age 6 years can be greatly improved by a fire in advance of seedfall. If no burning is done, mechanical site treatment is imperative.

While burning is the most practical measure, an additional treatment with an implement such as a scaribedder—with or without supplemental seeding—may improve chances for regeneration. Mechanical treatments may be particularly useful where brush competition is severe; in this study their effect was to improve survival rather than to increase tree percent.

Table 4.—*Estimated[1] natural seed requirements to provide 500 superior crop seedlings per acre at age 6*

Treatment	Good site	Poor site
	M seeds per acre	
No burn		
Disk	488	2,050
Rototill	230	290
Roto-cultipack	53	102
Scaribed	64	233
Chemical	509	650
None	400	2,500
Winter burn		
Disk	40	87
Rototill	37	94
Roto-cultipack	55	80
Scaribed	38	43
Chemical	42	62
None	63	92
Fall burn		
Disk	40	78
Rototill	36	50
Roto-cultipack	32	89
Scaribed	30	56
Chemical	56	72
None	51	71

[1] Established seedlings per acre needed = (100/survival percent) (2,500). Seeds per acre needed = (100/tree percent) (established seedlings/acre needed).

When preceded by a burn and effective mechanical site preparation, supplemental seeding at a rate of 20,000 repellent-coated seeds per acre established adequate stands during each of the poor seed years.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

PROTECT

Use Pesticides Safely

FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE

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